LIQUID COOLING SYSTEM

The invention relates to a liquid cooling system having several cooling units, which are individually assigned to electronic component groups, which are housed in a rack or switchgear cabinet and are to be cooled, and furthermore having a monitoring and control arrangement for monitoring the cooling temperature.

Such a liquid cooling system is disclosed in DE 196 09 651 C2 in connection with a switchgear cabinet air-conditioning arrangement. In this case the liquid cooling system is designed, for example, as a cooling device or cooling unit with an air/water heat exchanger and represents a component of the entire air- conditioning arrangement, which is monitored and controlled or regulated by means of a higher-order monitoring and control arrangement. It is possible by means of the cooling system, together with the monitoring and control arrangement, to realize varied control concepts of the air-conditioning arrangement, depending on its type of employment or the wishes of the user. In this connection there is also the possibility of locally cooling individual electronic component groups, for which purpose fan units, which have been assigned to them, are triggered. However, if a rack or a switchgear cabinet is equipped with a multitude of electronic component groups with high computer output, very large amounts of heat can collect, in particular in the area of the computer units, which are difficult to remove even with such a cooling arrangement.

A switchgear cabinet monitoring and control system is described in WO 97/34345, into which an air-conditioning device with a cooling apparatus and fans, as well as heat exchangers, have been integrated inter alia. A cooling concept for removing heat in the vicinity of individual component groups is not further described in this publication.

The object of the invention is based on making available a liquid cooling system of the type mentioned at the outset, by means of which cooling can be dependably provided, in particular in case of a large packing density of electronic component groups in the rack or switchgear cabinet, and heat damage to the electronic component groups can be prevented.

This object is attained by means of the characteristics of claim 1. In this connection it is provided for the cooling units to be embodied as liquid cooling units and to be connected via branch points to a common central liquid line system integrated into the rack or switchgear cabinet, and that the control and monitoring arrangement is embodied for monitoring the cooling temperature in the central liquid line system and for emitting an error signal when a predetermined or predeterminable threshold temperature in a liquid return branch is exceeded, or a predetermined or predeterminable threshold temperature difference between a temperature in an inlet branch and a temperature in the return branch is exceeded, or when the liquid flow falls below a predetermined or predeterminable threshold value.

The electronic component groups are dependably cooled with a high degree of effectiveness by means of the liquid cooling units assigned to them. In the course of this, excess heating is dependably detected by monitoring the cooling temperature and/or the flow in the central liquid line system and, if required, is taken into consideration in the system by emitting an appropriate error signal, or by appropriate processing.

Damage to the electronic component groups to be cooled is prevented dependably and by simple means in that the error signal is used for triggering an alarm and/or for switching off a common electric current supply for all electronic component groups.

Particularly effective cooling is achieved in that the cooling units have cooling elements through which coolant flows, and which are thermally connected to temperature-sensitive, heat- producing electronic components.

A well arranged construction with simple connecting possibilities is obtained in that the central liquid line system has a line unit provided with an inlet conduit and a return conduit, which is mounted vertically oriented in the rack or switchgear cabinet and is provided over its length with coupling means, preferably equidistantly arranged, for forming branch points.

The steps, wherein a section of the central liquid line system extending in the rack or switchgear cabinet is attached to a vertical frame leg, to at least one mounting rail, or to the inside of a lining element, contribute to a simple construction with easy mounting options.

In this connection advantageous arrangement possibilities arise in that a receptacle, open over its length toward the interior of the rack or switchgear cabinet, is integrated on or into the frame leg, into which the section of the central liquid line system is inserted.

Different embodiment variations for effective cooling consist in that the central liquid line system is connected to an air/liquid heat exchanger and/or a liquid/liquid heat exchanger, and furthermore in that the liquid/liquid heat exchanger is connected to a recooling arrangement.

The invention will be explained in greater detail in what follows by means of exemplary embodiments and by making reference to the drawings.

The drawing shows a schematic representation of an example of the structure of a liquid cooling system for cooling a multitude of electronic component groups 1 installed

in a rack 2, each of which has at least one central processing unit (CPU) 1.1 of high computing output as the main heat producer in a housing containing the electronic components group 1.

For cooling the electronic component group 1, in particular the processor units or computer units 1.1 embodied as integrated components, cooling elements 4 of the liquid cooling units, which are provided with conduits, have been applied in tight heat- conducting contact to the component element body, through which the coolant is conducted over as long a possible a path. The liquid cooling units with the cooling elements 4 are connected via respective inlet branch lines and return branch lines by means of respective branch points 5.1 with coupling elements to a vertical section of a central liquid line system 5 extending in the rack. The central liquid line system 5 also has an inlet branch 5.2 and a return branch 5.3 for the coolant, wherein the vertical section arranged in the rack 2, or switchgear cabinet, is preferably designed as a line unit 5.4 with the inlet branch 5.2 and the return branch 5.3.

The line unit 5.4 is connected in its lower area via a further section of the inlet branch 5.2 and the return branch 5.3 to a water/water heat exchanger 6, which is received in an electronic housing 3. A monitoring and control arrangement 9 for the functions of the switchgear cabinet or rack 2 is received in the electronic housing 3 which, inter alia, is also connected to the inlet branch 5.2 and the return branch 5.3 for detecting the temperature of the liquid, or the water, prevailing there.

A simple recooling unit or a fan arrangement is/are also conceivable for cooling the liquid.

The water/water heat exchanger 6 is connected via further lines to a recooling arrangement 7, which assures dependable cooling of the coolant and presents, for example, the opportunity of also giving off the created heat outside of the room in which the rack 2 or

the switchgear cabinet with the electronic component groups to be cooled are located, in order to prevent too high a room temperature.

Furthermore, the upper area of the vertical section of the central liquid line system 5 is connected by means of further lines to an air/water heat exchanger 8 arranged on the rack 2 or switchgear cabinet, by means of which further cooling is achieved and wherein, with an appropriate design, the general temperature in the area of the component groups, or in the interior of the switchgear cabinet, can also be reduced.

Furthermore, by way of example, a monitor keyboard unit 10 and a server switch control are arranged in the rack 2 which, however, because of their low heat production, need not be connected to the central liquid line system 5.

If by means of temperature sensors or liquid flow monitors the monitoring and control arrangement 9 detects in or at the liquid line system that, for example, the absolute temperature in the return branch 5.3, or a temperature difference between the inlet branch 5.2 and the return branch 5.3 exceeds a predetermined or predeterminable threshold, it emits an error signal or an error report, by means of which a warning light or a warning sound can be switched on, for example, or a display for informing the user can be controlled, wherein this can also be passed on to a remote monitoring station via a network connection. An advantageous step also consists in that the monitoring and control arrangement 9 is designed in such a way that, in case of the appearance of an error signal, it switches off a common electrical current supply 1, so that it is assured that no damage on account of the temperature occurs in this arrangement which, as a rule, is very expensive. Also, a more extensive computer-operated processing of the error signal, and/or the storage in a error memory device for diagnosis or later evaluation can be provided. In this case the monitoring and control arrangement 9 constitutes a higher-order monitoring system, with which still other sensor

signals can be received and monitored, as well as various actuators of the cooling system can be controlled and regulated, such as explained in greater detail in the publications DE 196 09 651 C2 and WO 97/34345 mentioned at the outset.

The vertical section of the central liquid line system 5 arranged in the rack or switchgear cabinet 5 is preferably embodied as a line unit with an inlet conduit and a return conduit, and can be separately arranged in the interior of the rack 2 or the switchgear cabinet, for example on a vertical frame leg, on mounting rails or on the inside of a lining element. An embodiment is also particularly advantageous, wherein a vertical frame leg has a U-shaped receptacle, open over its length toward the interior of the rack 2 or switchgear cabinet, into which the line unit can be inserted later and fixed in place, for example snapped in. Connecting points with coupling elements for connecting the branch lines leading to the electronic component groups 2 are provided at regular spacings over the length of the line unit 5.4.